Formation of Marine Biological Thin Layers: Recruitment of Zooplankton

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LONG-TERM GOAL

Our long term goal is to understand bioluminescent plankton spatial and temporal distributions, and how these distributions affect plankton sensory interactions. Current interest is in how these interactions might be involved in “thin layers”.

OBJECTIVES

The central objective was to measure bioluminescence in association with thin layers, since this has never been attempted, which required: 1) measuring the vertical distribution of excitable bioluminescence across thin layers; and 2) determining the plankton species responsible for bioluminescence in the vicinity of thin layers.

APPROACH

The 1998 Thin Layer study site involved multi-disciplinary collaborations, and thus bioluminescence profiles were compared with a suite of other parameters such as marine snow concentrations, zooplankton distributions, fluorescence, and hydrographic measurements. A new small, profiling bathyphotometer (Case, Herren, Haddock UCSB) measured total stimulable bioluminescence through 21 m depth from a moored station aboard the *RV Henderson*. Plankton collections were made by conventional sampling, and from these samples bioluminescence potential was measured in a laboratory integrating sphere photometer. An independent estimate of plankton numbers was obtained on the same

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profiling package with an 8-frequency TAPS (TRACOR acoustic profiling system, Dr. D. V. Holliday, TRACOR Aerospace, Inc.)

Concurrent measurements of marine snow concentrations were taken with a profiling *in situ* still-camera package (Dr. Alice Alldredge, UCSB, MacIntyre *et al.* 1995). To quantify the intensity of potential bioluminescence incorporated within marine snow versus surrounding water, we used SCUBA techniques to collect individual marine snow aggregates and samples of surrounding water (Haddock 1997). The collected samples were mechanically stimulated during their night phase in an integrating sphere with photometer to determine total stimulable bioluminescence. Dry weights of snow samples, and marine snow concentrations (via the Alldredge *in situ* profiling still-camera) in the water column were also measured. Species identification is in progress with video microscopy.

WORK COMPLETED

Software was designed for data collection from the bioluminescence profiler and integrating sphere instrument. Total stimulable bioluminescence from samples was successfully recorded at night on 5 days, following collection of the samples by SCUBA during daylight hours on those days. Choice of collection depths for the snow samples was based on real time profiles of fluorescence and zooplankton density distribution peaks as displayed by the TAPS acoustic profiler.

RESULTS

We investigated the co-occurrence of bioluminescence and zooplankton distributions, and conducted the first field test of a newly developed small bioluminescence bathyphotometer. Preliminary data analysis shows that daytime profiles consist of a persistent bioluminescent and fluorescent signal, perhaps due to abundant *Noctiluca* sp (Figure 1), that coincided with the base of the thermocline. With the onset of darkness, the overall intensity of the daytime bioluminescence peak increased. Other distinct bioluminescent peaks appeared at dusk at greater depths, and persisted until dawn. However, these peaks were not linked to fluorescence maxima or to areas where marine snow concentrations were high. The relationship of these nighttime bioluminescent peaks to zooplankton distributions is currently under analysis.

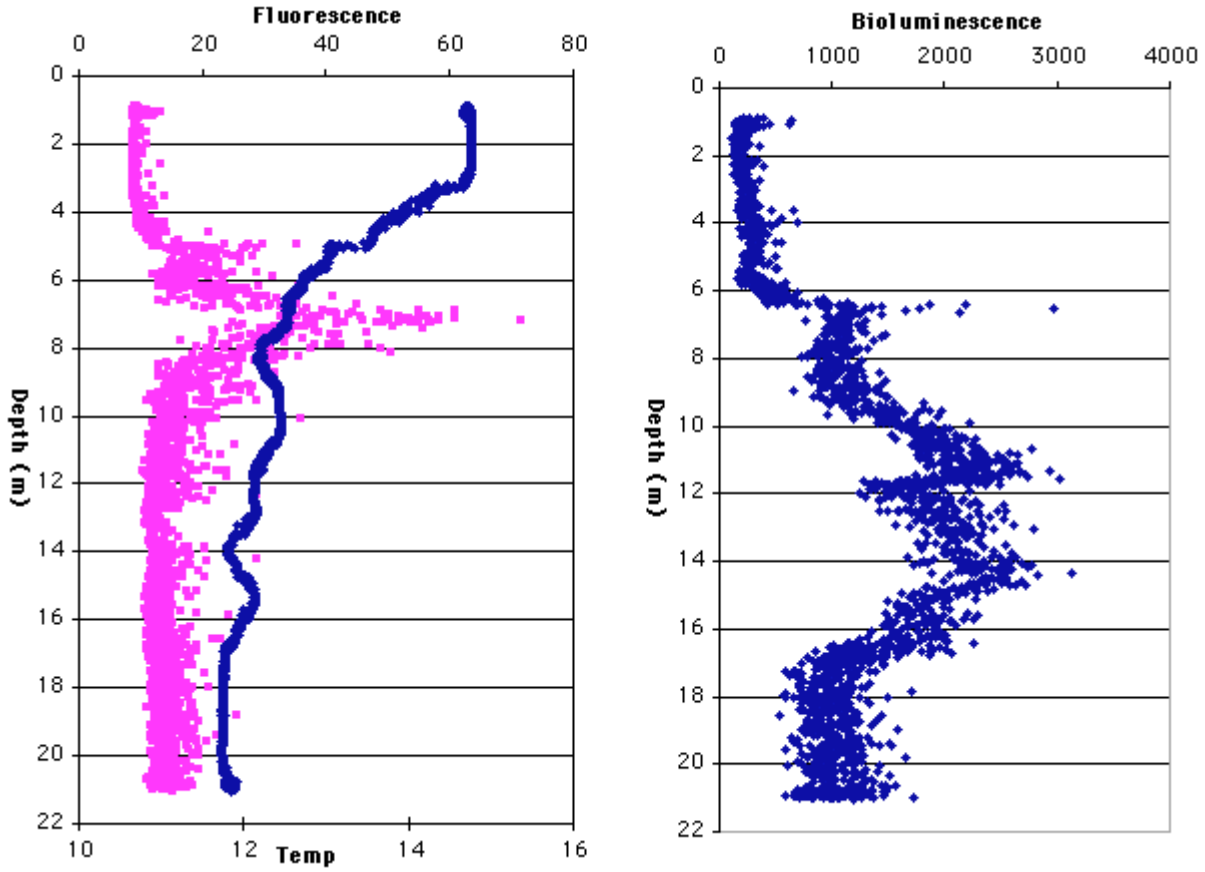

Figure 1: A representative graph of simultaneous profiles of fluorescence (relative units), temperature (°C), and total stimulable bioluminescence (relative units) in 20 m at night in East Sound, WA, the 1998 Thin Layers Study Site.

IMPACT/APPLICATIONS

Nocturnal bioluminescence associated with thin layers, as perhaps from luminescent dinoflagellates, would suggest the possibility that zooplankton might be attracted into thin layers, since zooplankton are demonstrably affected by dinoflagellate bioluminescence. If confirmed then thin layers might, under proper conditions, give a significant return to acoustic devices, and thus render still more complex the shallow water acoustic environment.

TRANSITIONS

Successful use of the new bioluminescence detector demonstrates the utility of an identical unit being prepared for use on an autonomous underwater vehicle, REMUS. The detector will also be tested for its applicability for profiling operations from small boats.

RELATED PROJECTS

1 - James Case (Santa Barbara) – The bathyphotometer used in this study to measure the bioluminescence potential of the water column was developed under another closely associated grant . The bathyphotometer was calibrated and field-tested during the East Sound study in June 1998.

2 - Van Holiday (Tracor) – We are examining correlations between zooplankton distributions measured acoustically by Holiday and distributions of microstructure and marine snow.

3 - Jan Rines (Rhode Island) – Dr. Rines is providing us with valuable taxonomic information regarding phytoplankton in East Sound. She is frequently contacted for information regarding marine snow diatom composition.

REFERENCES

Haddock, Steven H. D. 1997 Doctoral Thesis, University of California Santa Barbara.

MacIntyre, S., A.L. Alldredge and C.C. Gotschalk 1995. Accumulation of marine snow at density discontinuities in the water column. Limnol. Oceanogr. 40:449-468.